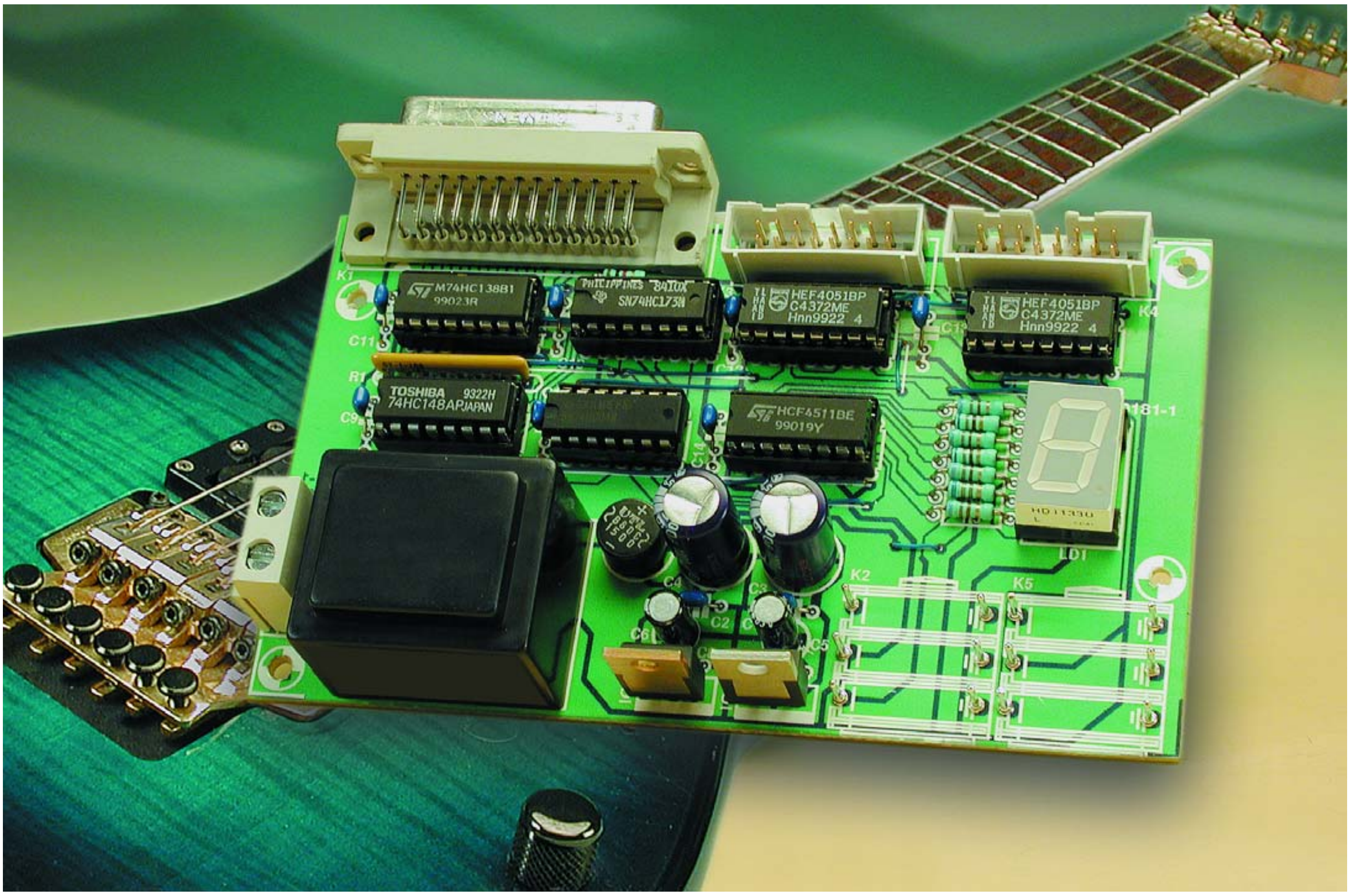
Guitar Effects Switchbox

Design by T. Rooney Poms

This effects switchbox will help make the stage a safer and tidier place. All your effects units can be kept out of harm's way and seamlessly operated using a single footswitch.



Guitar effects units such as distortion, flanger or phaser are fiddly to switch on and off. Each effects unit has its own mechanical switch. In order to select a particular effect, first that effect must be switched on and then the others switched off (or vice versa). Since it is rather tricky to operate the switches simultaneously, a seamless changeover is impractical. The circuit described here solves this problem in a simple and effective way. It is not limited to switching guitar effects in and out, but is suitable for similar applications where analogue signals are passed through a chain of units.

The guitar effects switch is foot-operated. As usual for such devices, the control for the unit is a separate footswitch, the remainder of the circuit (i.e. the logic circuitry for the effects switch and the effects units

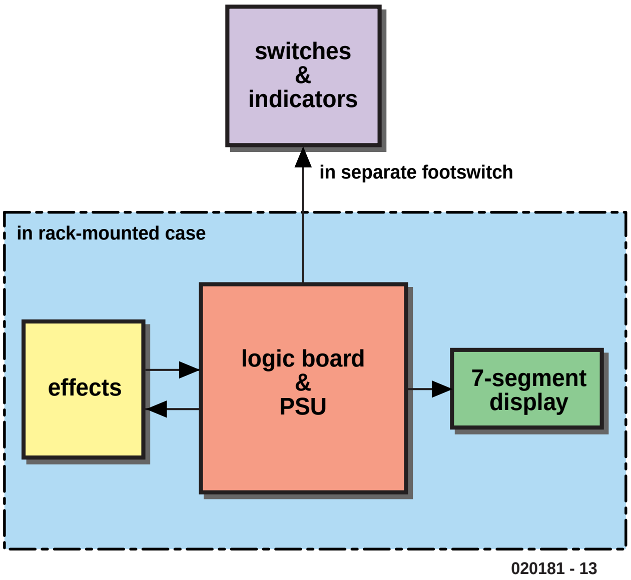


Figure 1. The effects switch and the effects units are kept in the rack: only the footswitch appears on the stage.

themselves) being mounted in a rack (**Figure 1**). The trick is that the effects are not selected using switches, but rather using buttons. The logic ensures that the effect remains active when the foot is removed from the button until the next time a button is pressed. This means that cables carrying audio signals are kept safely in the rack rather than being trailed around the stage. The connection between the foot control and the logic circuit carries just the switching signals.

Keyboard encoder

At the heart of the circuit in **Figure 2** is an 8-input priority encoder type 74HC148, with D-type flip-flops (IC2) connected to its output. This device generates a 3-bit control signal according to the button that has been pressed. The inputs to the 74HC148 are active low; when no button is pressed, all inputs are high. When a button is pressed the corresponding input is taken to ground. A binary encoded signal then appears at outputs 1A to 3A, which is stored in three flip-flops of the 74HC173. In order that this value is held when the button is released, the 74HC173 must be clocked to latch the encoder's outputs. This clock can be derived from the GS (A) output (pin 14) of the priority encoder. The output swings from high to low when a button is pressed. The signal must therefore be inverted (using a 74HC04 inverter) to clock the 74HC173. Not only that: in order to ensure that the IC is only clocked when the 3-bit control signal is valid, two further inverters provide an small additional delay to the clock signal. The three remaining inverters are not used and so have their inputs connected to ground. The 3-bit control signal from the output of IC2 forms a bus that is connected to four ICs.

Analogue switches and displays on the bus

Two of these ICs are type 74HC4051 analogue multiplexers. Up to eight effects units can be connected between these multiplexers via connectors K3 (input) and K4 (output). The guitar is connected to connector K2, the amplifier to K5. The 4051 is a low-cost choice for the switch: a pin-compatible alternative is the MAX4617 from Maxim which, although much more expensive and harder to obtain, has superior performance: it offers a very low R_{ON} and an excellent channel-to-channel separation of –93 dB. A comparison of the data sheets shows the clear difference in performance:

http://pdfserv.maxim-ic.com/arpdf/MAX4617-MAX4619.pdf
http://www.philipslogic.com/products/hc/pdf/74hc4051.pdf

The two other ICs connected to the 3-bit control bus drive displays to shown the selected channel or effect. The channel number is shown on a common cathode 7-segment display on the device itself, which is driven by BCD-to-7-segment decoder IC6 (type 4511). The unused control input of the 4511 (pin 6) is connected to ground. The 4511 is capable of driving 10 mA per output, and this value should not be exceeded. The value of the series resistors required for the 7-segment display will depend on the type chosen. For the type recommended in the parts list, 680 Ω is suitable.

The selected channel is also indicated by LEDs on the foot control. For this IC3, a 74HC238 3-to-8 line decoder/demultiplexer, is used to convert the 3-bit control signal into individual outputs. The eight outputs of the IC are connected to LEDs D1 to D8 in the foot control via a 25-way D connector. Since the 74HC238 does not have a particularly high output drive, low-current LEDs are required in the foot control, with a forward current of no more than a few milliamps.

All the ICs connected to the 3-bit control bus operate 'transparently'; that is to say, that they do not require clock or enable signals to be activated before processing their inputs.

A regulated 5 V supply is required for the logic circuitry, while the analogue part (the two analogue multiplexers) requires a symmetrical supply to pass the audio signals through faithfully. For this reason a symmetrical power supply with a 9 V mains transformer with two secondary windings is required, along with two voltage regulators (a 7805 and a 7905). Since the maximum current consumption of the circuit is only around 10 mA, heatsinks are not required for the voltage regulators.

Construction

Now we look at the construction of the circuit. As will be seen from the printed circuit board layout in **Figure 3**, the layout has not been specially designed for use in a rack enclosure. This makes for a compact and economical single-sided printed circuit board at the cost of a certain amount of extra wiring. First fit the several (insulated) wire links near to and under the ICs, and then proceed with

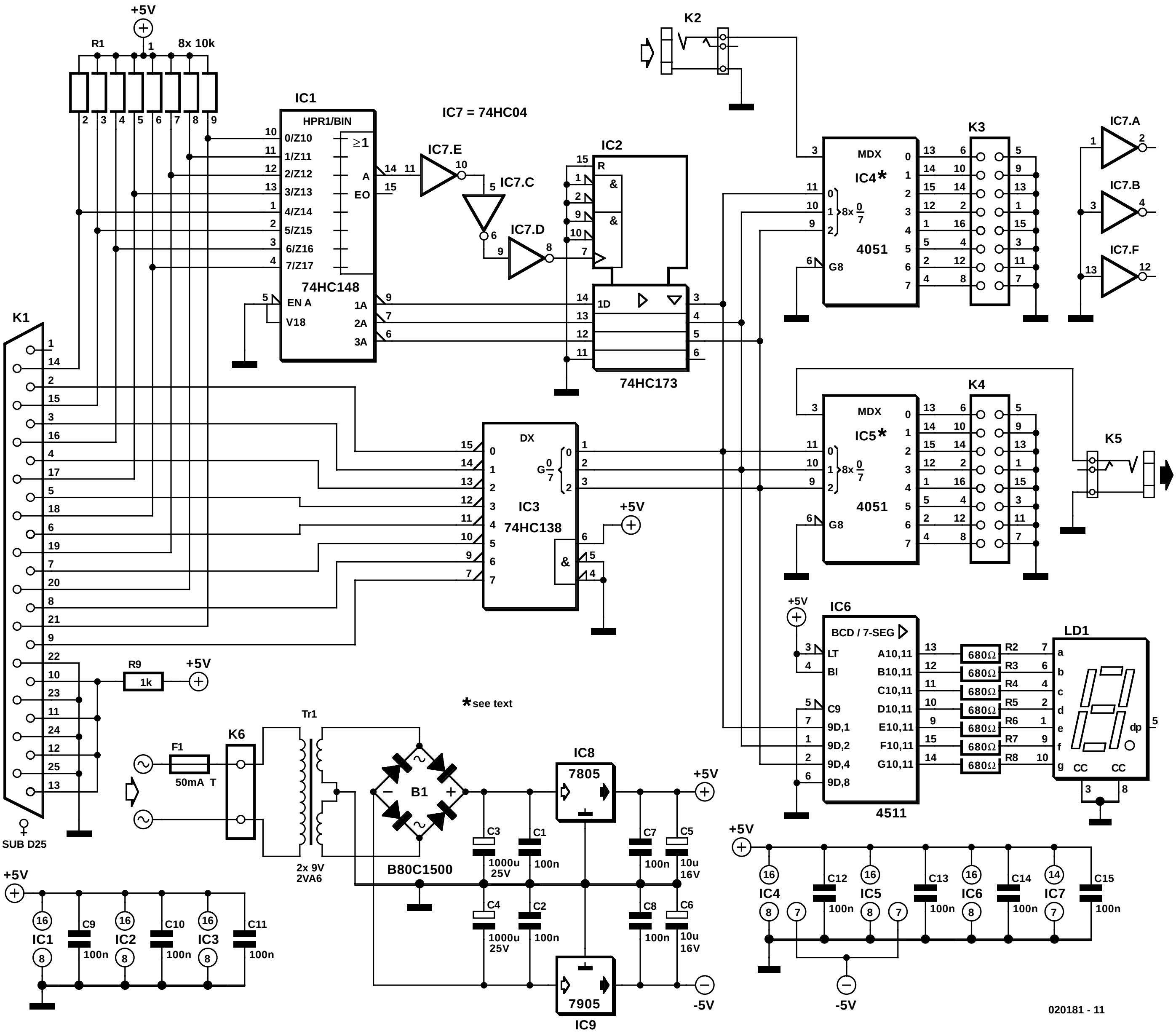
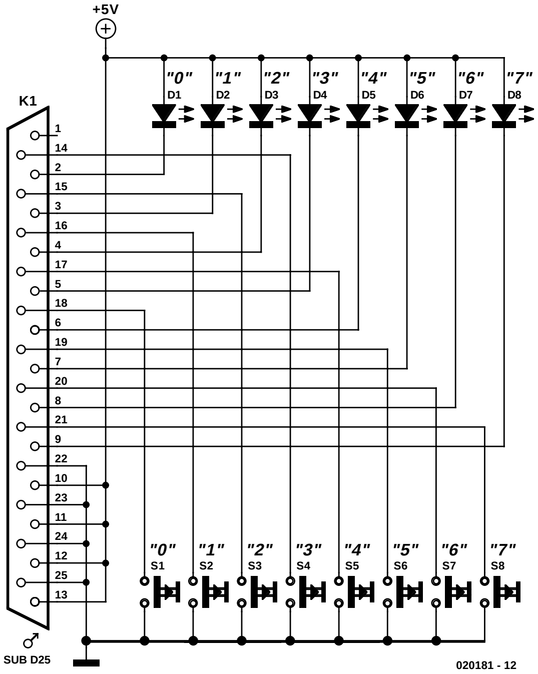


Figure 2. The effects switch circuit employs only standard logic ICs.



the resistors, capacitors and IC sockets (or preferably good quality SIL socket strips). Finally fit the larger components: the jack sockets, transformer and connectors. One point to note: the 7-segment display can easily be mounted directly on the front panel next to the two jack sockets by using a right-angled IC socket (for example Conrad Electronics # 188379).

In order to test the circuit before embarking on a large amount of cabling, it is best to construct the footswitch first. As far as we know, enclosures for eight footswitches are not available: the biggest we could find was a six-way unit from Marshall, and so home construction is

COMPONENTS LIST

Effects switch

Resistors:

R1 = 8-way SIL array, 10kΩ
R2-R8 = 680Ω

Capacitors:

C1,C2,C7-C15 = 100nF radial
C3,C4 = 1000µF 25V radial
C5,C6 = 10µF 16V radial

Semiconductors:

B1 = B80C1500 bridge rectifier in round case (80V piv, 1.5A)
IC1 = 74HC148
IC2 = 74HC173
IC3 = 74HC138
IC4,IC5 = 4051 or MAX4617*
IC6 = 74HC04
IC8 = 7805
IC9 = 7905
LD1 = 7-segment display with common cathode (e.g., HD1133O, Siemens)

Miscellaneous:

K1 = 25-way sub-D socket (female), PCB mount, angled pins
K2,K5 = mono jack socket, 6.35 mm, PCB mount
K3,K4 = 16-way boxheader
K6 = 2-way PCB terminal block, lead pitch 7.5mm
Tr1 = mains transformer 2×9V/2.6VA (Hahn BV EI 303 2016)
IEC mains appliance inlet with integrated fuse holder
16 mono jack sockets, 6.35mm, chassis mounting
PCB, order code **020181-1** (see Readers Services page)

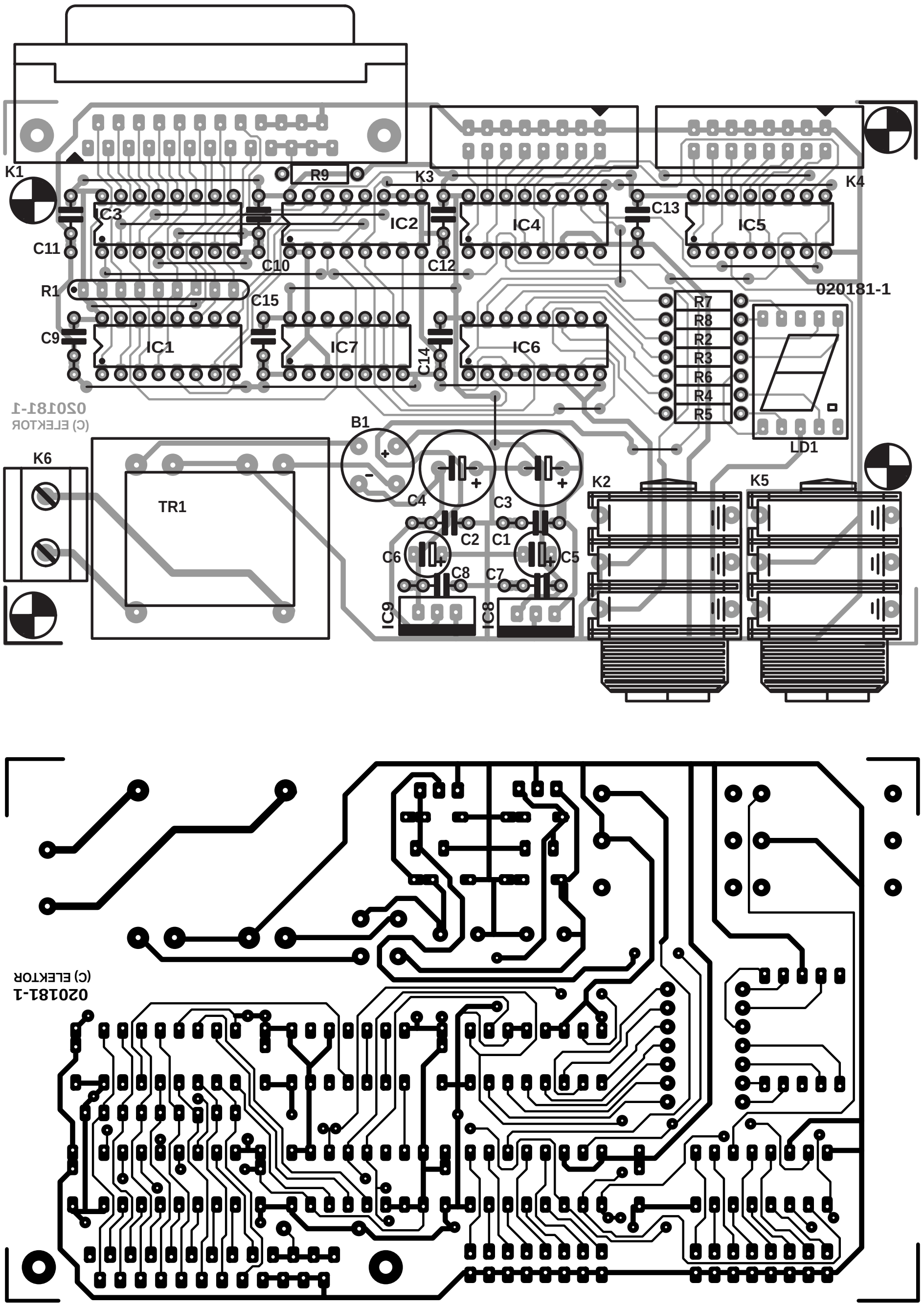


Figure 3. The compact printed circuit board layout.

COMPONENTS LIST

Footswitch

Semiconductors:

D1-D8 = LED, 3mm, low current

Miscellaneous:

K1 = 25-way sub-D plug (male)
S1-S8 = footswitch (e.g., Monacor/Monarch FS-10)

required. This at least has the advantage that the dimensions of the unit can take the shoe size of the guitarist into account! A printed circuit board layout is not necessary, since the eight buttons, the eight LEDs and the 25-way D-type connector can be wired individually.

Once the footswitch is ready and connected to the control logic using an ordinary computer cable, the circuit can be tested. First, with the ICs not fitted, apply mains power and check that the correct voltages are found at the right pins of all the IC sockets. If so, switch off the power and fit the logic ICs. The circuit can now be quickly tested by pressing the footswitches in turn. If the appropriate number appears on the display and the correct LED lights on the footswitch, the circuit is working correctly. The two box headers can now be wired to the 16 corresponding jack sockets, using unscreened cable as long as the distance involved is no more than an inch or two.

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